CONTENTS.

THE HAWAIIAN PLANTERS' MONTHLY

PUBLISHED FOR THE

HAWAIIAN SUGAR PLANTERS' ASSOCIATION

[Entered at the Post Office at Honolulu, T. H., as Second-class matter.]

VOL. XXVII.] HONOLULU, SEPTEMBER 15, 1908. No. 9.

SUGAR PRICES FOR MONTH ENDED SEPTEMBER 14, 1908.

1908.		Centrifugals.	Beets.	Parity.
Aug.	10.....	4.08¢	10s 2¼d	4.15¢
"	11.....	4.08¢	10s 0¾d	4.12¢
"	12.....	4.08¢	10s 0¾d	4.12¢
"	13.....	4.08¢	10s 0¾d	4.12¢
"	14.....	4.08¢	10s 1½d	4.14¢
"	15.....	4.08¢	10s 0¾d	4.12¢
"	17.....	4.08¢	10s	4.11¢
"	18.....	4.00¢	10s 0¾d	4.12¢
"	19.....	4.00¢	10s 0¾d	4.12¢
"	20.....	4.00c	9s 10½d	4.07¢
"	21.....	4.00¢	9s 9d	4.04¢
"	22.....	4.00¢	9s 9d	4.04¢
"	24.....	4.00c	9s 9d	4.04¢
"	25.....	4.00¢	9s 9d	4.04¢
"	26.....	3.95¢	9s 4½d	3.96¢
"	27.....	3.95¢	9s 4½d	3.96¢
"	28.....	3.90¢	9s 5¼d	3.98¢
"	29.....	3.90¢	9s 5¼d	3.98¢
"	31.....	3.90¢	9s 5¼d	3.98¢
Sept.	1.....	3.885¢	9s 6d	3.99¢
"	2.....	3.885¢	9s 7½d	4.01c
"	3.....	3.885¢	9s 7½d	4.01¢
"	4.....	3.885¢	9s 7½d	4.01c
"	5.....	3.885¢	9s 7½d	4.01¢
"	7.....	3.885¢	9s 7½d	4.01¢
"	8.....	3.885¢	9s 6¾d	4.00¢
"	9.....	3.90¢	9s 5¼d	3.98¢
"	10.....	3.90¢	9s 6d	3.99¢
"	11.....	3.90¢	9s 8¼d	4.03¢
"	12.....	3.90¢	9s 8¼d	4.03¢
"	14.....	3.90¢	9s 7½d	4.01¢

Willett & Gray's Weekly Statistical of August 27 and Sept. 3, states:

RAWS.

August 27.—The decline in prices which has been going on for several weeks is still unchecked.

The weakness is general in the markets of the world and has effected the values of sugar of the old crop more than those of the new crop, bringing the prices of the two together.

Spot quotations which were nominally on basis of 4.08 for 96° test last week, are now 3.90c., at which Centrifugals in store here were placed with the principal buyers.

Cuba sugars for August-September shipment were sold at 2½c. c. & f., 95° test, equal to 3.92c. landed for 96° test ,as Cuba Centrifugals are now testing very low.

Unsold Javas afloat, some having passed Gibraltar ordered to the Breakwater, and others a little further off, were offered at 10s. 6d. c. f. & i., equal to 3.97c. landed, without interesting buyers.

Receipts for the week at the Atlantic ports were heavy, amounting to 44,917 tons, including 29,860 tons Javas, of which one cargo each at Philadelphia and Boston and three cargoes at New York. Supplies of Java Sugars will now be large each week for several months.

In the London market quotations for Javas declined to 10s. 7½d., equal to 3.96c. landed at New York.

Beet sugars of the old crop (August and September) declined to 9s. 5¼d.; the parity of 3.98c. for Centrifugals, with the new crop (October-December) also at 9s. 5¼d.

The decline has extended further than was generally anticipated, and an opinion, based on the experience of many years, would be that prices should be not very far from the bottom, particularly as new crop Beet sugars are now quoted near the cost of production, where there will be strong resistance to further decline. But the future depends upon the amount of pressure exerted by holders. All cane sugars in sight will be needed before the new Cuba crop is available in quantity, and present prices can only be maintained by refraining from forcing sugars upon refiners, already well supplied, until needed.

Practically all growing crops are making good progress.

September 3.—The decline, which has extended for several weeks, has finally been checked.

All unfavorable conditions have been discounted and a further decline is not warranted at this time. No boom is anticipated, but there is reason to expect a firm market for the immediate future.

Because of the resistance on the part of holders to the making of further concession, but few transactions were recorded during the week under review, the business done being confined principally to Java sugars.

Two cargoes of Javas afloat for September arrival, were sold to Arbuckle and Federal at 10s. and 10s. 1½d. c. f. & i., equal to 3.87c. and 3.90c., respectively. Toward the close, however, the market recovered, and a cargo of Javas due to arrive this week was sold to the McCahan refinery, Philadelphia, at 10s. 5¼d. c. f. & i., equal to 3.96c. landed, at which we now quote spot Centrifugals, 96° test, showing an advance of .06c. for the week. There are still other Java cargoes, for October arrival, some of which, it is said, the owners may order to the United Kingdom, to be held there until wanted.

The balance of old crop Cuba sugars available for shipment is reduced to about 35,000 tons, which is offered only sparingly from time to time, the lowest price now named being 2 9-16c. c. & f., 95° test, equal to 3.98c. for 96° test, the Cuba sugars now testing low as a rule; there are New York buyers at 1-32c. less, or equal to 3.95c. for 96° test.

Some refiners are not as well supplied as others, and moderate offerings should find a market at fair values.

According to our cables, the weather in Cuba is still favorable to the development of the growing cane. Our Havana correspondents write that many sections report that the cane has already begun to lay down, owing to its size, and that prospects of the crop are promising. Harvesting is expected to commence in December. The political outlook is improved, but some parties still look forward to the time when the new government takes office (about February 1st) with a little apprehension.

In Europe beet sugars did not decline below the quotation of last week, 9s. 5¼d., but slowly recovered and advanced, at the close, to 9s. 8¼d. for September, the parity of 4.03c. for Centrifugals; 9s. 7¼d. for October, and to 9s. 10½d. for May delivery. Java sugars on the London market closed at 10s. 6d., the parity of 3.94c. for 96° at New York.

Mr. F. O. Licht cabled us on Tuesday that the weather in Germany favors the growing beet crop. Today, others report the weather wet and cold.

Czarnikow, Macdougall & Co., under date of August 28 and September 4, report:

August 28.—The stagnation of last week in the raw sugar market has been broken this week, but at the expense of sellers, who, finding it impossible to make progress in the disposal of Cubas for shipment and of Porto Ricos and Cubas lying here, finally granted the further concessions demanded by buyers.

On moderate transactions the spot market declined early in the week to 3.85c., and Cubas to 2.59c. c. f., basis 96°. This decline failed to evoke any general interest on the part of buyers, and it was not until some tired holders of sugars in store reduced their price to 3.90c., basis 96°, that further business resulted. This establishes for the time being a spot price of 3.90c. for 96° Centrif-

ugals, and makes the value of Cubas for shipment 2.54c. c. f., basis 96°.

The course of European Beets, as well as the absence of the long expected heavy demand for refined, but particularly the latter, have brought about the present unlooked for situation. Even now, after the great decline that has taken place in raws, those refiners who are only partly supplied ahead refrain from anticipating their coming wants more than is absolutely necessary, and hence the restriction of business to moderate transactions in spot and nearby sugars.

The downward tendency in the Beet market appears to have been checked, for quotations for both old and new crops show a slight recovery from the lowest of the week. As compared with the prices ruling at the end of April prompt Beets are 2s. 6d. lower, and new crop, October-December, is 1s. 1½d. lower. The decline in our spot market has more than kept pace with that of prompt beets. Thus, against a spot market in April of 4.49c., basis 96°, we are now at 3.90c., same basis, a difference of .50c. per lb., or 2s. 9d. per cwt. Our spot market is now .08c. below the landed equivalent of Beets at today's quotations of 9s. 5¼d. f. o. b.

The European Beet markets are lower than they were a week ago for all deliveries, excepting January-March, which is unchanged. At the close the market shows considerable steadiness, with prices of old and new crops on the same level. Today's f. o. b. quotations are: August, 9s. 5¼d.; September, 9s. 5¼d.; New Crop, October-December, 9s. 5¼d.; January-March, 9s. 6¾d.

It is noteworthy that today's European Beet quotation is 3¾d. below the lowest recorded this year for prompt sugar, namely, 9s. 9d. f. o. b. on February 19th. New Crop is also lower than it has been at any time in the present year prior to this week. It is easy to see that reports of unfavorable weather in the beet districts could readily cause considerable reaction from prices which seem to have discounted all favorable news.

September 4.—In the first few days of the week the raw sugar market hung fire and no business was done. Refiners persistently refused offers at last price of Cubas for shipment, and intimated that they would not be interested unless sellers made a further concession of 1-16c., which no seller was willing to do.

Eventually the sale of a Java steamer cargo, due here about 24th instant, at 10s. c. i. f., and of another, due ten days earlier, at 10s. 1½d., c. i. f., gave more confidence to the market, in spite of the fact that these prices represented only 3.86c. and 3.89c. respectively on the spot. This confidence became more pronounced when 10s. 5¼d. c. i. f. was subsequently obtained for a cargo then about due and since arrived, the last transaction being equivalent to a sale at 3.96c. landed and marking an advance of 1-16c. upon last week's price for spot sugars.

No sales of Cubas are reported, but it is believed that some business has been done at 2.50c. c. f. and 2.53c . c. f., basis 95°. Buyers are still in the market at 2.53c. c. f., basis 95°, but sellers are holding off.

The change of temper on the part of refiners is mainly due to the very active and heavy demand which has arisen for their refined product, a demand which must be met by an increase in meltings, for which some, at least, of our refiners had not made provision by securing an adequate working supply of raws.

European Beet markets have shared in the improvement, prices for all positions being 3¼d. to 3¾d. higher on the week. To-day's f. o. b. quotations are: September, 9s. 9d.; New Crop, October-December, 9s. 8¾d.; January-March, 9s. 10d.; May, 10s. Less favorable weather is reported from some parts of the Continent.

NOTES.

ANNUAL MEETING OF PLANTERS.—The annual meeting of the Hawaiian Sugar Planters' Association will be held in Honolulu on November 9th to 12th inclusive. Many of the plantation managers are away from the Islands and it is expected that there will not be as large an attendance as in past years. The interest in these meetings has been growing from year to year; the attendance has largely increased.

At this annual meeting there will be the usual round of reports from the following committees:

Cultivation, Fertilization and Irrigation on Irrigated Plantations:—H. P. Baldwin, Chairman; Andrew Adams, L. Weinzheimer, G. F. Renton, H. A. Baldwin.

Cultivation and Fertilization on Unirrigated Plantations:—John A. Scott, Chairman; John Watt, James Gibb, W. G. Ogg, A. Lidgate.

Cutting, Loading and General Transportation:—W. W. Goodale, Chairman; Albert Horner, Geo. Watt, J. T. Moir, W. Stodart.

Manufacture of Sugar and Utilization of By-Products:—J. N. S. Williams, Chairman; John Hind, Geo. Ross, G. H. Fairchild, L. Barkhausen.

Machinery:—(a) MANUFACTURE: W. J. Dyer, Chairman; C. C. Kennedy, Wm. Searby, F. Weber, E. K. Bull.

(b) AGRICULTURE: Albert Horner, Chairman; J. T. Moir, E. H. Broadbent, F. F. Baldwin, W. W. Goodale.

Warehouses for, and Storage of, Raw Sugar:—C B. Wells, Chairman; J. N. S. Williams, John Hind, J. T. Moir, B. D. Baldwin.

Forestry:—L. A. Thurston, Chairman; Geo. H. Fairchild, W. W. Goodale, H. A. Baldwin, A. Ahrens.

Experiment Station:—J. P. Cooke, Chairman; W. M. Giffard, Geo. H. Robertson, Geo. F. Davies, W. Pfotenhauer, J. W. Waldron, R. D. Mead.

Labor:—E. D. Tenney, Chairman; W. Pfotenhauer, E. E. Paxton, R. D. Mead.

CROP REPORTS.—As nearly all of the plantations have finished grinding it is possible to show very closely the total outturn for the crop. Thus far the figures total 520,000 tons. This constitutes the banner crop of the Islands, and an increase over last year of 80,000 tons. The increase is due very largely to the absence of injurious insect pests and diseases, to better cultivation, and to the remarkably favorable growing season.

The following is the outturn, in short tons, of the ten largest plantations:

Hawaiian Commercial & Sugar Co.	56,150	tons
Oahu Sugar Company	35,320	"
Ewa Plantation Co.	33,919	"
Waialua Agricultural Co.	30,376	"
Pioneer Mill Co.	27,146	"
Maui Agricultural Co.	22,627	"
Hawaiian Sugar Co.	21,633	"
Honolulu Plantation Co.	18,996	"
Onomea Sugar Co.	17,006	"
Olaa Sugar Co.	15,795	"

The coming crop will not be as large as the one just harvested, although it is yet too early to make a close estimate. The growing season has not been as favorable as for the last crop and there has been no reported increase in acreage. It is not expected that the crop of 1908-1909 will reach the five hundred thousand mark, and an unfavorable cold wet winter will make much difference in the total outturn.

PROGRESS IN SUGAR CANE EXPERIMENTS IN QUEENSLAND.

There has just come to hand the seventh Annual Report upon Sugar Experiment Stations in Queensland. The report, which is dated November 7, 1907, is from the pen of Dr. Walter Maxwell, and, containing as it does the results of many experiments, forms a very valuable contribution to the scientific study of the sugar cane. A short notice of the more salient points is given below:

Variety Experiments.—The necessity for growing the most efficient varieties has been felt as much in Queensland as in other sugar districts, but whereas elsewhere progress in this direction has tended towards the raising of new varieties from seed, owing to climatic conditions this method is impracticable in Queensland. Dr. Maxwell has therefore hoped to obtain more rapid results by the introduction of varieties occurring in New Guinea*; it is mentioned, however, that several seedlings obtained by the Queensland Acclimatization Society and by the Hambledon Mill are under trial.

The new varieties which have given so far the most promising results in Queensland are the New Guinea varieties 8 A, 15, 24, 24 A, 24 B; in four crops these varieties grown experimentally yielded respectively 30.5, 30.5, 34.0, 31.7 and 29.8 tons of sugar per acre; that is to say, this was the actual amount of sugar produced per acre, and not that won in the factory. The average purity of the juice from these canes is extremely high, that of N. G.** 15 averaging 94.2 over a four crop rotation.

Included in the report are statements of opinion of the merits of the new varieties grown in nurseries on several plantations, and there, too, there seems to be a general coincidence with the results obtained at the Experiment Station, more especially with regard to N. G. 8 A, 24, 24 A, and 24 B, N. G. 15 in several instances receiving unfavorable comment.

Included in the report are detailed descriptions of these and other canes, which we here reproduce in full, as, so far as the writer knows, descriptions of these canes have not yet been given:

* The writer of this review sees no reason for supposing that these varieties may not originally have been self sown seedlings, or, indeed, that there is any evidence to show that the older and better known varieties did not at some comparatively remote time thus originate from a primitive type of cane; in this way it may be supposed that some intelligent South Sea Islander thus obtained the original Lahaina cane which had become a standard variety at the time of the arrival of the first European visitors.

** N. G.=New Guinea.

New Guinea 8A (New Guinea name, Gogari).—A dull, deep green cane of moderately stout habit, turning a reddish color on exposure. Internodes usually 4 to 6 inches long, and occasionally grooved. Habit lodging. Trashes easily. Flesh yellow. A sparse arrower at station. Spring planting appears to suit this variety best.

New Guinea 15 (New Guinea name, Badila).—A dark purple to black colored cane. Stout sticks, with pronounced white waxy rings at nodes. Internodes usually 2 to 3 inches long, but some times longer, especially in ratoon cane. Habit erect; foliage also somewhat erect and very green. Eyes generally full and prominent. Trashes easily. Has never arrowed at station. The foliage of very young cane has a slightly reddish tinge. Flesh white and highly saccharine. A remarkably heavy cane, often weighing 1 lb. per foot. Greatly appreciated by laborers, as it is so easily cut, trashed and loaded.

New Guinea 24 (New Guinea name, Goru or Goru possi possana).—A greenish brown to copper colored cane, moderately stout. Joints have a pronounced zigzag appearance. Internodes usually from 3 to 4 inches long. This cane has a slight waxy bloom. Habit: inclined to lodge. Basal end develops roots, and upper eyes sometimes shoot. Foliage broad and plentiful. Trashes readily. Flesh yellow. A sparse arrower at station. This is a very favorite cane at Cairns and Mossman, where from 50 to 70 per cent. of the whole crop is Goru.

New Guinea 24A (New Guinea name, Goru Scela Scelana).—Like No. 24 (Goru) in appearance and color, but is distinctly marked with longitudinal reddish colored stripes. Moderately stout. Internodes 3 to 4 inches long. Habit: lodging. Foliage broad and plentiful. Trashes easily. Flesh yellow. Has never arrowed at station.

New Guinea 24B (New Guinea name, Goru Bunu Bunana).—This cane also resembles No. 24 (Goru) in shape, though not in color, which varies from yellow to yellowish green. On exposure the skin of this cane is sometimes marked with reddish granular spots. Internodes usually 3 to 4 inches long. Eyes full and prominent. Foliage broad and plentiful. Trashes readily. Flesh yellow. A very sparse arrower at station. New Guinea 24B is more upright in growth than either 24 or 24A, and is somewhat thicker. It is a nice clean cane to handle, and should be a favorite with cutters.

New Guinea 64 (New Guinea name unknown).—A brownish to olive greenish cane with longitudinal claret colored stripes and small linear skin cracks. Moderately stout. Internodes usually from 3 to 5 inches long, contracted at nodes and bulging towards centers. The foliage of this cane is remarkable, being of a red

to purple color when the plant is young. As the cane progresses towards maturity the leaves become greener, but never wholly lose a purple tint. It is a sparse stoler, but the sticks generally grow to great length. Flesh white. Trashes very easily. Arrows to some extent at Mackay Station.

Trinidad Seedling No. 60.—A stout bluish purple cane covered with a white waxy bloom. Habit erect. Internodes usually 2½ to 4 inches long. Flesh soft and white. Eyes prominent and somewhat incline dto shoot. Foliage of medium breadth and erect in growth. Trashes easily. A few canes arrow at station.

Mauritius Bois Rouge.—An olive green cane with a marked red blush. When exposed the red color frequently predominates. Sticks thin; habit erect. Internodes usually from 5 to 6 inches long and slightly concave. Eyes small. Foliage rather narrow. Trash adheres to some extent. An early and full arrower at station.

Mauritius Settlers.—A dull green thin cane. Habit erect. Internodes 3½ to 5 inches long, occasionally showing longitudinal linear skin cracks. Eyes very prominent and sharply pointed. Foliage of medium width. Somewhat erect. Trashes with some difficulty. A sparse arrower at station.

Of the canes described above the H. S. P. A. Station has under trial the Badilla, or N. G. 15, but so far it has not yet given evidence of the good qualities it possesses in Queensland.

Cultural Experiments.—Details are given of the results of experiments devised to demonstrate the benefits of subsoiling and cultivation, and to determine the most advisable distance between rows and between plants in the row. It was found that in an unmanured and unirrigated plot subsoiling and cultivation increased the yield by 11.9 tons of cane, or by 1.7 tons of sugar per acre.

The experiments on the amount of seed and the distance between rows led Dr. Maxwell to the following conclusions:

"Firstly, one plant with three eyes, with 6 inches between the plants in the row, is indicated to be the best way of planting the seed in the row.

"Secondly, it is also indicated that any increase in the distance between the rows exceeding 5 feet is likely to result in a lower weight of cane and yield of sugar per acre, while less than 5 feet between the rows can result in an increase of cane and sugar per acre."

Segregation Experiments.—A number of varieties, including such well known canes as Meerah, Striped Singapore, Rose Bamboo, Striped Louisiana, Tibboo Merd, D 74 and D 95, which had shown signs of being affected with disease, have been grown and studied separately and one of the results of this study is thus given by Dr. Maxwell:

"Acidity determinations were made on all the samples, but these do not tend to confirm Dr. Erwin Smith's opinion (quoted in last year's report) that the immunity of certain canes from the gumming disease is probably due to their high acidity, for although the average acidity is slightly higher in the canes apparently unaffected, yet some individual varieties in which the disease was seen have given a higher acidity test than those in which it was not observed. The acidity in canes growing upon other portions of the station cannot be compared with the acidity in the hospital canes, for the reason that the former are ratoons growing upon old limed lands, while the latter are plant, growing upon virgin soil."

N. D.

TOTAL SOLIDS IN MILL PRODUCTS BY THE REFRACTOMETER.

By S. S. Peck.

Introduction.

The inapplicability of the Brix spindle to the determination of the total solids of molasses, due to the varying specific gravities of the non-sugars, has been the subject of frequent contributions to sugar journals. For the determination of apparent purity, which suffices for the ordinary sugar-house control, the results are comparative and serviceable. But for the correct analysis of low grade products, which should include the sucrose by the Clerget process and the actual solids, other methods must be used. Drying on quartz sand or pumice stone at the temperature of boiling water at atmospheric or under reduced pressure has been the method usually employed, under various modifications. E. E. Hartmann[1] obtained satisfactory results by drying the molasses in a weighed test tube containing a thin roll of paper, diluted with a small quantity of water, and placed in boiling water while a current of dried air is drawn through. He considered the operation complete in two and a half hours. In a series of determinations of molasses, H. C. Prinsen-Geerligs obtained the dry matter by drying a weighed amount of a molasses of definite dilution on filter paper in a Scheibler dish at a temperature between 100° and 105° C. until constant weight was obtained. He had previously demonstrated[2] that it is the mineral matter which causes the greatest proportion of the discrepancy between Brix readings and true solids, but could find no fixed factor which could be applied to the former as a correction for the salts, to serve as a correction for true solid substance[3]; while several years previous to this[4] he had concluded that no relation exists

between figures for Brix polarization, water, and purity. T. E. Halligan[5] conducted a series of determinations of the total solids in a molasses wherein he found that by drying the molasses for ten hours in a water oven at 98° he obtained results conforming very closely to the vacuum method. Prolonged drying produced results considerably lower. This was doubtless due to the constant decomposition of certain lime compounds in the molasses, derived from the combination of lime with the invert sugar, or perhaps even of levulose alone. The high heat of drying is not necessary to effect this decomposition and liberation of gaseous compounds, such as formic or acetic acid. It is observable in the phenomenon known as "froth fermentation," frequently produced by over-liming or over-heating during latter boilings of molasses. E. C. Shorey[6] ascribed this to the decomposition of lime glycollate and J. Lely[7] to lime salts of glucinic acid, or the acid itself which decomposes above 65° C. into formic, acetic, and carbonic acid; but whatever the cause, the result is the same during the determination of solids in molasses by drying at too high temperature for any prolonged period, viz., the formation of gaseous decomposition compounds, and too low result as solid matter. This difficulty of a correct determination has been largely if not completely solved by the discovery of the applicability of the use of the refractometer for this purpose.

The refractive index of a substance is defined by Wiley[8] as "an expression to characterize the measurement of the degree of deflection caused in a ray of light in passing from one transparent medium into another." The instruments used for this purpose are called refractometers, and heretofore have been mainly used as one means of identifying or detecting the sophistication of oils, butter, lard, etc. The two principal instruments are those designed by Abbe and Pulfrich. These register the refractive indices of the substances under examination; but modifications, such as the oleorefractometer and butyrorefractometer, are made with arbitrary scales adjusted to the measurements of oils or butters. It is not improbable if the refractometer finds an extended application in the sugar laboratories, that instruments will be made that will render reference to tables unnecessary, but will give readings of total solids directly on the scale; just as the polariscope today gives direct sugar percentages instead of degrees of optical rotation.

Of the two refractometers, the Abbe and Pulfrich, the former is more convenient, inasmuch as in the latter it is necessary to read by the yellow or sodium light, whereas in the latter, ordinary white light or that of a lamp can be used. The first reference we find to work in this direction is that by Tolman and Smith.[9] Their work was undertaken to test the value and accuracy of the Abbe refractometer for the estimation of sugars, to check up Stolle's[10] work on sugars, made with a Pulfrich instrument, and

to carry the research into sugars not treated by him. They show that sucrose and glucose have the same index of refraction from 1 to 90%, while other sugars, with which we are not concerned, differ only very slightly.

The first practical application of the Abbe refractometer was made by Hugh Main[11] who found in this instrument a most satisfactory substitute for the determination of water in refinery syrups for the usual slow and unsatisfactory methods of drying in sand, etc. He also prepared a table for the refractive indices of sugar solution at 20° C. which is practically identical with that of Tolman and Smith, showing the absolute reliability of the instrument in this respect.

The further extension of the use of the refractometer to more impure solutions has been more recently demonstrated by Prinsen-Geerligs.[12] This writer first determined a table of the refractive indices of sugar solutions at a temperature of 28°, which is more suitable for tropical conditions, together with a table of corrections, which are reproduced in tables I and II, the figures in the first table having been figured for each division on the refractometer scale to the fourth decimal place by the writer. He then applied these figures to solutions of the various non-sugars occurring in molasses and found that sodium salts have almost the same indices, calcium salts higher, and salts of potash lower than that of sucrose. He then shows that in mixtures of a syrup of known composition, containing sucrose, glucose, and fructose in about the same proportion as exists in molasses, with sodium, potassium, and calcium glucinates (glucose decomposition products) the refractive index gave results approximating very closely to actual dry substance. A mixture of the syrup with the residue from fermentation and distillation of molasses, gave equally satisfactory results. Mr. Prinsen-Geerligs then gives some highly interesting figures from actual determinations of various mill products and remarks that "the method of dessication is not beyond suspicion for molasses and products containing much glucose, and is apt to give wrong figures, because of the retention of moisture by the viscous fluid as well as on account of the driving off of products of decomposition by the prolonged heating. If there is a difference between the figure for dry substance by the refractometer and by dessication, we are not at all sure that the latter figure is the correct one."

Molasses.

Twenty-five samples of waste or final molasses were examined by this Station for the purpose of comparing results obtained by dessication and the refractometer. The total solids were determined by drying for a period not greater than four hours in a water jacketed oven, under a vacuum of 20 inches and at 100° C.

For this purpose flat dishes were covered with quartz sand which had been washed in acid, to a depth of about 5 mm. These were ignited, and weighed, with a small, dry stirring rod. About two grams of molasses were used in each determination, being dissolved in the smallest possible quantity of distilled water. Drying was usually complete in two hours, and always in four. Concordantly with these determinations, the refractive index was observed, and total solids calculated from Prinsen-Geerlig's tables. The results are given in the following table:

SOLIDS IN FINAL MOLASSES BY DRYING AND FROM REFRACTOMETER.

	Refract. Index.	Temp.	Solids from Table.	Solids by Dessication.	Difference.
1	1.4935	27.5°	81.76	81.99	— .23
2	1.4975	28.0°	83.35	83.47	— .12
3	1.4986	28.0°	83.75	81.94	+1.81
4	1.4998	27.0°	84.15	83.77	+ .38
5	1.4719	27.0°	73.22	71.67	+1.55
6	1.4886	27.5°	79.86	79.20	+ .66
7	1.4976	27.5°	83.36	83.45	— .09
8	1.4943	27.5°	82.06	82.46	— .40
9	1.4957	28.0°	82.63	82.04	+ .59
10	1.4877	27.5°	79.51	79.62	— .11
11	1.4979	28.0°	83.50	82.32	+1.18
12	1.5015	30.0°	85.00	86.16	—1.16
13	1.4953	28.0°	82.50	82.03	+ .47
14	1.5046	28.0°	86.00	85.40	+ .60
15	1.4942	27.5°	82.01	82.66	— .65
16	1.4971	28.0°	83.20	82.00	+1.20
17	1.4992	28.0°	84.00	84.30	— .30
18	1.5068	29.0°	86.91	86.02	+ .89
19	1.4926	28.0°	81.45	81.32	+ .13
20	1.5018	28.0°	84.95	86.63	—1.28
21	1.4947	28.5°	82.29	82.51	— .22
22	1.4970	30.0°	83.30	84.05	— .75
23	1.4875	28.0°	79.50	79.56	— .06
24	1.4973	27.5°	83.21	83.18	+ .03
25	1.5006	28.0°	84.53	84.47	+ .06
	Average		82.64	84.49	+ .15

The refractometer used was an Abbe refractometer made by Zeiss, with heatable prisms. The refractive index for water at 28° was 1.3320. The temperature was kept constant by circulating water, held in a bottle with tubular side-opening, through the refractometer to a large vessel, whence it was dipped back to the bottle. The slight variations noted in temperature were due to the changing temperature of the laboratory. The instru-

ment was placed near a door with a southern exposure, and with purer solutions gave a well defined shade that could be read on repeated trials by the same or different observers to the same place on the scale. With the molasses the shadow was considerably obscured, and it was only after considerable practice in reading and adjusting the eye-piece that concordant results could be obtained. When the image is too obscure, or when the molasses is seen to contain any considerable quantity of crystals, due either to false grain or a break in the centrifugal gauze, it is necessary to resort to dilution. Diluting the sample in nickel dishes with a large surface area did not give very satisfactory results, due to uncertainty as to when solution was completely effected, and difficulty in preventing evaporation during weighing. It was found better to weigh the molasses in tared flasks with necks of small diameter, dissolving completely with hot water, and after cooling and weighing, determining the refractive index. No attempt was made to get any precise dilution, but the percentage determined from the weights before and after the addition of water. Two samples of molasses gave the following results:

	No. 12.	No. 20.
Total solids, drying	86.16	86.63
Total solids, refractometer	85.00	84.95
Total solids, from diluted solution, drying.	86.51	——
Total solids, from diluted solution, refractometer	85.60	87.83

Molasses No. 20 contained a considerable quantity of grain: the refractometer would naturally give too low a figure for total solids in such an instance, when the observation is made without dilution.

Thin Juices and Syrup.

Through the kindness of two of the Oahu plantations, a comparison of refractometer determinations of total solids in the various juices with those made by the usual instrument, the Brix spindle, was made at the mills. In one mill there was found a record of comparisons made between total solids by spindling and by the drying of these juices. In the following tables we give in addition to the total solids by the Brix spindle and refractometer, the average figures obtained by the chemist of the mill by dessication, with the average Brix from the same juices. These averages, taken from juices analyzed at an entirely different period, approach very closely to the differences between the average Brix readings and the corresponding averages from the refractometer.

	Total Solids, Refractometer.	Total Solids, Brix.	Difference.
Crusher Juice	19.17	19.42	—.25
	20.89	21.15	—.26
	21.23	21.32	—.09
	20.42	20.71	—.29
	21.67	21.83	—.16
	21.12	21.27	—.13
Average	20.75	20.95	—.20
Average by drying*	20.45	20.89	—.44
Third Mill Juice	4.64	4.93	—.29
	5.85	5.93	—.08
	6.99	7.02	—.03
	6.79	6.59	+.20
	6.79	6.28	+.51
Average	6.21	6.15	+.06
Average by drying*	5.83	5.96	—.13
Fourth Mill Juice	3.34	3.68	—.34
	4.07	3.46	+.61
	3.94	4.67	—.73
	4.54	4.80	—.26
	5.24	5.05	+.19
	4.24	4.52	—.28
Average	4.23	4.36	—.13
Average by drying*	3.23	3.36	—.13
Mixed Juice	14.82	15.16	—.34
	16.30	16.33	—.03
	16.77	16.93	—.16
	16.82	17.27	—.45
	17.72	17.78	—.06
	15.97	16.11	—.14
Average	16.40	16.59	—.19
Average by drying**	14.24	14.63	—.39

* Average of three determinations.

** Average of six determinations.

	Total Solids, Refractometer.	Total Solids, Brix.	Difference.
Clarified Juice	15.12	15.35	—.23
	15.33	15.53	—.23
	16.92	16.98	—.06
	17.32	17.62	—.30
	17.22	17.33	—.11
	16.82	17.00	—.18
Average	16.46	16.64	—.18
Average by drying†	14.48	15.01	—.53
Press Juice	9.98	10.03	—.05
	7.78	7.81	—.03
	11.18	11.21	—.03
	12.18	12.50	—.32
	11.73	11.76	—.03
	12.38	12.53	—.15
Average	10.87	10.97	—.10
Average by drying‡	9.26	9.39	—.13
Syrup	59.79	61.30	—1.51
	63.09	63.66	— .57
	65.19	66.20	—1.01
	66.09	67.32	—1.23
	65.19	66.70	—1.51
	65.84	67.20	—1.36
Average	64.20	65.40	—1.20
Average by drying**	63.38	64.10	— .72

In some instances, the determinations show considerable variation, particularly with the third and fourth mill juices, where plus differences, for some unaccountable reason, appear. However, the brix determinations of these juices are uncertain factors, due particularly to the large amount of air in the samples and the difficulty of a precise reading owing to the foam on the surface when in the cylinder. The refractometer readings, on the contrary, are not affected by such causes. The samples, after being cooled to room temperature, were filtered in a covered funnel, and after a few drops had passed through, a couple of

† Average of four determinations.

‡ Average of five determinations.

**Average of six determinarions.

drops were placed on the refractometer glass and the reading taken. It was observed that considerable care was necessary to prevent concentration due to evaporation, even syrup of 66 Brix showing considerable differences in the refractive indices after being allowed to stand in uncovered vessels for brief periods.

The large difference between the solids in syrup determined by the two methods was very surprising, considering that they were of equal purities with the clarified juices, and it should therefore be expected that equally concordant results would be obtained. For a more exact determination, a sample of syrup was brought to the Station laboratory. This had a refractive index of 1.4483 at 27°, equivalent to 63.32% total solids. By dessication the percentage was 63.26%, while the Brix, obtained from the specific gravity by pykometer, was 63.76%, showing a difference of —.44% by the refractometer.

The third and fourth mill juices were tried at the mill with the pykometer and the brix calculated therefrom. The average of the differences in two trials will be seen from the following table to approach very closely to those obtained by drying:

	Total Solids, Refractometer.	Brix from Specific Gravity.	Difference.
Third Mill Juice	6.59	6.80	—.21
	5.14	5.20	—.06
Average	....	....	—.14
Fourth Mill Juice	3.79	4.22	—.43
	3.14	3.16	—.02
Average	....	....	—.22

Residual Juice.

Attempts were made to determine the total solids in the residual juice, but the following table of solids in the diffused liquor shows that the results were widely divergent from those obtained with the pykometer::

Refractometer.	Pyknometer.	Difference.
.95	.64	+.31
.64	.60	+.04
.54	.66	—.12
.54	.59	—.05
.54	.62	—.08
.64	.50	+.14
.69	.59	+.10

In addition to the unsatisfactory nature of these results, a further objection to the use of the refractometer in this determination is the large difference in purity resulting from a small dif-

ference in the fourth decimal place. The scale on the instrument is graduated to the third decimal place, the fourth being interpolated, and as the divisions are not very large, a difference of one can possibly be made by two different observers. With a diffused liquor containing, say .33% sucrose, such a difference would mean a variation of fully five degrees in purity. It seems safe to conclude that under the present method of determining solids in the residual juice in the bagasse, the refractometer finds no place.

Massecuites.

Two samples of massecuite were supplied by this mill and brought to the laboratory for determination of solids. These samples were very closely boiled and showed a brix of about 96 to 97 by the usual mill laboratory method of dilution and spindling. In determining the refractive indices, the procedure followed was to weigh out about 20 grams in a tared beaker, dissolve perfectly in hot water, transfer to a 50 cc. stoppered tared flask, cool, weigh, and determine the refractive index. The results from the No. 1 and No. 2 massecuites follow:

Massecuite.	Brix Pyknometer.	Total Solids Refractometer.	Dessication.	Difference.
1	95.04	93.02	93.22	—.20
2	97.42	94.05	93.91	+.14

The results are entirely satisfactory, and while extreme care is necessary to effect perfect solution and to make accurate weighings, this is justified by the great saving of time in making the determinations and the perfect confidence to be felt in their accuracy.

Control of Boiling to String Proof.

A test was then made of the application of the instrument to controlling the concentration to a definite density, when boiling to string proof. For this purpose, the refractometer was installed on the pan floor and a convenient arrangement for carrying water through the prisms secured. An hour after the complement of No. 3 molasses was drawn in, (a full strike was not made, as there was not sufficient molasses on hand), when boiling down had commenced, samples were taken from the proof stick and rapidly placed on the prism of the instrument. A couple of minutes were allowed to let the prisms reach the temperature of the circulating water, and the reading taken. The following table gives the complete data obtained:

Time.	Refractive Index.	Temperature.	Total Solids.
1:35	1.4937	27°	81.77
1:45	1.4968	28°	83.05
1:55	1.4982	28°	83.60
2:05	1.4992	30°	84.15
2:15	1.5013	30°	84.95
2:25	1.5030	31°	85.63
2:35	1.5050	31°	86.38
2:45	1.5055	31°	86.56

The pan was struck as the last sample was taken. Samples from the cooler cars and tanks showed the No. 3 and No. 4 massecuites from previous strikes to have total solids of 86.35 and 85.20%, respectively. The last figure is not very far from that found in the observed strike, especially when we consider that it is possible that some grain had already separated from the magma.

It is suggested that the refractometer would be a very effectual instrument to use in controlling the boiling of low grade products. By keeping a complete record of a series of boilings of different purities and their yields, each mill could learn the optimum extent to which concentration should be carried, and more definite results would be achieved. No precise figures could be given for every mill on account of the varying nature not only of the molasses due to the character of the juices, methods of clarification and subsequent treatment of the juices, but also on account of differences in pans and storage facilities.

Boiling to a definite percentage of solids in the massecuite is possible by the use of the Brasmoscope, which depends on the accurate measurement of the temperature of the boiling mass and of the pressure in the pan. The use and application of this instrument, with the necessary table, has been fully described by Noël Deerr in a previous bulletin of this Station.[13] While this instrument is perhaps superior to the refractometer in that it can be used when boiling to grain, it has the disadvantages of the necessity of placing attachments on the pan itself, and the need of precise thermometric and barometric readings. The refractometer is an effectual substitute when boiling to string-proof, and not as difficult of application. Placed conveniently on a pan floor with a good light and connection with running water, it offers no difficulties to use by even the most inexperienced hands; and with proper and adequate care as regards cleanliness, it will last indefinitely.

Correcting Brix Spindles.

The refractometer offers a rapid and convenient method for checking the correctness of the graduations on Brix spindles.

This laboratory has recently had occasion to examine several spindles. The method employed was to take a solution of granulated sugar, bring it to the temperature at which the instrument was graduated (in this instance 27.5° C.), take the reading on the spindle, and then find the correct sucrose content by polarization. On this occasion, in addition to the polarimetric determination, the refractive indices were found, and the sucrose calculated from Prinsen-Geerligs' table.

The results by polariscope and refractometer were as follows:

Polariscope.	Refractometer.
2.0	2.05
4.6	4.60
12.8	12.85
19.2	19.20
23.8	23.85
32.0	32.10
39.1	39.20
41.6	41.70
45.7	45.80
53.2	53.15
58.8	58.90

In conclusion, the writer desires to express his obligation to the management and mill staffs of the Waialua Agricultural Company and Ewa Plantation Company for their courtesies and assistance in carrying out the investigations in their respective mills.

REFERENCES.

1. International Sugar Journal, Nov., 1903.
2. Archief voor de Java Suikerindustrie, 1902-3.
3. International Sugar Journal, Feb., 1906.
4. Sugar Cane, June, 1898.
5. Proceedings of the Association of Official Agricultural Chemists, 1904.
6. Journal American Chemical Society, Jan., 1899.
7. International Sugar Journal, April, 1906.
8. Principles and Practice of Agricultural Analysis, Vol. III.
9. Journal American Chemical Society, Oct., 1906.
10. Zeitschrift des Vereins der Deutschen Zucker-Industrie, 1901.
11. International Sugar Journal, Oct., 1907.
12. International Sugar Journal, Feb., 1908.
13. Bulletin No. 20, Division of Agriculture and Chemistry, H. S. P. A.

[NOTE—We omit H. C. Prinsen Geerligi's tables referred to in the text.—*Ed.*]

*CARBON BISULPHIDE USED IN GERMAN VINEYARDS.**

In most of the German vineyards the soil requires a rest after it has been covered with vines for a certain time. During this period of rest the "vine-tired" soil has time and opportunity to recuperate and is eventually put in a more favorable condition to support a new growth of vines.

This time of rest varies in length in different districts, and in many places is as long as ten to fifteen years. If the ground is not very stoney and is otherwise suitable for other cultivation, the rest period will not occasion much financial loss. But if, as is the case with many hillside vineyards, other cultivation is not feasible, there is no return for the capital invested in the land while it is idle.

Of course, the recuperation of the soil is the main purpose of the "rest-period," but if at the same time some return, even if small, can be had from the land, without interfering with the object in view, it is more than desirable.

It is evident that in cases where the "resting" of the ground occasions too great a financial loss, one is anxious to shorten the period of rest as much as possible. As a means to this end much mention has been made of the use of Carbon Bisulphide. The method of treating the soil with Carbon Bisulphide is described below.

The use of Carbon Bisulphide in vine growing is comparatively old, although this substance was applied originally only as an insecticide. Its first use for this purpose was in France in the 70's of the last century.

It was soon noticed that if new plants were brought into vineyards which had recently been subjected to the Carbon Bisulphide treatment, such plants showed an unusually luxuriant growth. Attention to this fact was first called by Oberlin. During the period 1887-91 he observed that letture, cabbage, beets, grain and alfalfa showed especially remarkable growth on treated soil.

These discoveries induced Oberlin in 1889, 1892 and 1893 to treat various vineyards with Carbon Bisulphide before planting. He published the result of his experiments in 1895, and stated that he believed it would be possible to rejuvenate vineyard soils by the new method, without the "resting." In so far as could be judged by his experiments in 1895, this belief seemed to be correct, as the young vines which he had planted in treated soil

* Enclosed herewith I hand you translation from the German of a lecture on Carbon Bisulphide used in German Vineyards, by a Government teacher of viticulture. It appears to me that some of the principles of this treatment could probably be applied to considerable advantage on some of our tired cane soils.—J. F. C. Hagens, Manager Pacific Guano and Fertilizer Co.

showed a better growth than vines which be planted in ground which had been given the usual "rest."

His discoveries resulted in experiments being begun in various viticultural districts, as in 1895 by the Mumm management in Johhannisberg, and later by other well known establishments. Oberlin also continued his work until 1902. The greatest use of the method is made in the vicinity of Deidesheim, Forst, Ruppertsberg, Konigsbach, Wachenheim, and Neustadt.

There is some variation i nthe method of application of the Carbon Bisulphide. In his first experiments Oberlin used 100 cc. (3½ oz.) of the substance per square meter and applied it at a depth of sixty centimeters (3 oz. per sq. yd.=depth 2 ft.). Later he became convinced that, in order to properly disinfect the soil, 200-300 cc., and in special cases 400 cc. of Carbon Bisulphide were required. The Mumm management used 250 grammes Carbon Bisulphide at a depth of 70 cm. At one place 200 grammes are used and poured into holes having a depth of 40 cm. (a centimeter is about four-tenths of an inch, 100 grammes per sq. meter is about 3 liquid ounces per sq. yd.).

The permeation of the ground (or "poisoning," as it is sometimes called) is carried out as follows: The holes are punched in the ground with an iron rod (crowbar) about 3 cms. thick (1¼ inch) to the required depth. The bottom of the hole should not be tamped nor the tool moved from side to side, as thereby the dissemination of the material to the sides would be hindered. The Carbon Bisulphide is poured into these holes with a measure and the hole immediately closed with earth and tamped or trodden. Sometimes also a form of injection is used.

While in many places only one hole is made per square meter the Mumm management divides the required quantity of Carbon Bisulphide per meter pouring it into five holes. Oberlin advised to make four holes per meter in very poor or tired soil. This point is largely decided by the nature of the ground. In a light soil in which the gases can diffuse freely, it is not necessary to make as many holes as in a heavy, dense soil.

In one district the disinfection is undertaken 5-6 weeks before planting. It would appear that an interval of 6 weeks should be the minimum.

In one case cuttings were planted 4 weeks after the application of the Carbon Bisulphide, making a poor growth the first year, and failing to start growth the second year, so that it became necessary to replant.

The Mumm management applies Carbon Bisulphide in July and August and plows only the following summer.

What results have been obtained thus far with Carbon Bisulphide? Chiefly it must be mentioned that the vines on treated soils show a most luxuriant growth. The length of the yearly growths by far exceeds that of vines on untreated soil. The consequence of this is that the soil is taxed for the necessary plant

food, and a replenishing by the addition of fertilizers is required.

As those vines always show a strong growth and luxuriant foliage, there is danger that the growers will neglect to supply the fertilizer. When it is considered that the ground is supplying more material than ordinarily, it is evident also that more plant food must be supplied, or the soil will rapidly become exhausted.

Of course, more frequent and careful pruning becomes necessary, for obvious reasons. A result of the strong growth and thick foliage will be an increase in the number of insect enemies and fungus diseases.

It has also been observed that treated ground will show an earlier crop than when untreated. While a result is not ordinarily expected from cuttings until the fifth or sixth year, treated ground has given a crop as early as the third year. The quantity of the crop is also considerably larger, sometimes being nearly doubled. (Of course, there is no certainty in the obtaining of such results.)

On the other hand the quality of the grapes is not so good as with the small crops, the sugar contents is less, and the acidity greater. But so far the investigations have not led to a definite decision in this regard, as the quality of the grapes may improve with the age of the vines.

The success of the method has not yet been definitely established. The first use of it was made 15 or 20 years ago, which is not sufficient time to decide the question. Should the early growth of the vines influence their vitality later, so as to weaken them and thus reduce the returns, the treatment is, of course, useless. It is further to be remembered that certain districts are noted for the particular quality of wine there produced, and if the quality of the grapes is injured by the Carbon Bisulphide treatment, this would be a serious drawback to its introduction.

It has been tried to treat old vineyards with Carbon Bisulphide so as to prolong the life of the grape vines, it being well known that the old vines produce grapes of high quality. In April, 1906, an experiment was made on an old vineyard by using 100 grammes Carbon Bisulphide per square meter of surface, at a depth of 40 cm. The growth which started the following summer was normal, but later a difference became apparent between the treated and untreated sections. At the end of May this difference was 1/3, end of June 1/4, later 1/5. The foliage of the vines on the treated ground was a yellowish green which darkened toward the end of the season. The following summer there was a decided improvement, the vines on treated ground developing better than the others. The final result has still to be determined.

Perhaps this temporary weakening of the vines might be overcome by a liberal use of fertilizers. It is held by Wortmann that through the use of Carbon Bisulphide many of the fine root fibres

of the vines are destroyed, and that this prevents the plants from obtaining the required sustenance. To offset this, it is proposed to supply an enlarged quantity of plant food.

How is this influence of Carbon Bisulphide to be explained? It is believed by some practitioners that the Carbon Bisulphide has a direct fertilizing action. But as this substance is poisonous to both plants and animals, the fertilizing theory cannot be correct. Moritz and Sherpe have shown that a small percentage is converted in the ground into sulphuric acid. This may have some value, but it does not agree with the visible action on the plants. The visible reaction on the plant indicates rather the presence of nitrogen. Neither of these possibilities give a satisfactory explanation.

It would appear that if the factor were known which exhausts, or tires, the soil for vine growing, that factor might be removed and the soil be again in the desired condition. Unfortunately, as yet not much is known in this relation.

The former theories were:

1. Exhaustion of the mineral plant foods.
2. Excretions of the roots which affected that particular species of plant, but not other vegetation.

This latter theory has been practically abandoned, at least it is no longer thought the chief or only cause.

One is now inclined to believe that the "tired" condition of the soil is produced by certain organisms, especially fungi and bacteria. It is well known that the soil harbors great quantities of bacteria which exist mainly in the upper layers of the soil. As such are known:

1. The decomposition bacteria "Nature's grave diggers."
2. The nitrification bacteria—which convert the ammonia produced by the former group into nitrous and nitric acids.
3. Denitrification bacteria—which consume nitrogen of the nitrates.
4. So-called Hiltner and Stormer bacteria and fungi, which exist partly on the roots of the plants as parasites, and partly in the vicinity of the roots, non-parasite. Hiltner and Stormer are of the opinion that the excretions of the plant root invite certain bacteria, which sometimes even occupy the outer layer of the roots.

The last-named investigators advance the idea that these bacteria have a certain interdependent relation which is destroyed or altered by the Carbon Bisulphide treatment—that the treatment does not entirely destroy the organisms (which has also been shown by Koch).

The influence of the Carbon Bisulphide is supposed to weaken certain species of fungi. Certain groups of bacteria are almost entirely destroyed, while others are hardly affected. This influence, of course, varies with the type of the soil, general conditions, duration of action, moisture, and quantity of Carbon Bisulphide

applied. In some instances it was determined that 70 to 75% of the total organisms were destroyed. They now feel justified in assuming that the denitrifying bacteria are almost entirely destroyed, and that the nitrifying bacteria are but temporarily affected. The bacteria not injured by the treatment belong to the group of "nitrogen gatherers," i. e., to the transmitters of the nitrification material. This latter group would, according to the theory, develop rapidly after the treatment. Thus the plant would be furnished with an increased quantity of available nitrogen.

An older theory advanced by Koch is that Carbon Bisulphide acts upon the roots of the plant as a stimulant, similar to some poisons on the human systems. Koch proved that a complete sterilization of the ground is not possible with Carbon Bisulphide, even if used in large quantities.

Koch's theory is objected to by Wollny, who believes a stimulating influence by Carbon Bisulphide impossible, because of its volatile nature. Against this it was shown by Moritz and Sherpe that the air in the soil, even near the surface, contained vapors of Carbon Bisulphide several months after the treatment.

Koch's view was more recently supported by Nobbe and Richter who suppose that Carbon Bisulphide exercises a similar influence as does ether when used in the forcing of plants.

Thus there are still wide differences of opinion as to the reason for the influence of Carbon Bisulphide upon the vine.

FISCHER, GEISENHEIM,
Government Teacher of Viticulture.

Translated from "Mitteilungen uber Weinbau unde Kellerwirtschaft. February and March, 1908.

Issued by Rud. Bechtold & Co., Wiesbaden, Germany.

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*PHOSPHATE ROCK AND SUPERPHOSPHATE.**

C. C. JAMES.

The subject of "Phosphate Rock and SuperPhosphate" is broad enough to fill several volumes, and it is not to be supposed that we can consider it thoroughly and in detail in the short space of half an hour or less. Phosphate rock alone is of such varied composition, and so different in physical structure that a mere description of the different varieties would be monotonous and

* Read at a meeting of the Hawaiian Chemists' Association, Sept. 5, 1908.

profitless. We will, therefore, confine ourselves to a brief history of some of the fields and to the phosphate rock of the South Seas with which we are more or less acquainted.

I do not know when phosphate rock first came into use. Experiments were made in England with Peruvian Guano in 1808 and bones were used for fertilizer as early as 1775. The American Indian was familiar with the fact that a fish placed under a hill of corn increased the yield appreciably; their attitude towards raw phosphates I do not know. Peruvian guano was introduced into the United States in 1832 and in 1837 the South Carolina phosphate rock was discovered by Francis S. Holmes, a professor of geology and paleontology in the Charleston College. He was greatly interested in numerous fossils, shells, teeth, bones, etc., in the rock found along the Ashley river, and what is known as the fish bed of the Charleston basin. The Charleston College museum has a collection of 6,000 specimens of sharks' teeth alone, some of which weigh from two to three pounds apiece, which were collected by Professor Holmes. The commercial and agricultural uses of these nodules containing shells and bones were not known until thirty years later when publications in England indicated the value of such deposits. In 1867 the samples were more carefully analyzed and found to contain 60% Calcium Phosphate. To the late Dr. N. A. Pratt of Charleston, is given the honor and credit of first having proven the wealth of the Carolina fields, and of founding the phosphate industry in the United States.

Phosphates were discovered in Florida in 1881, but it was not until 1889 that the find became public. In 1892, phosphate rock was discovered in Tennessee by Major W. J. Whitthorne of Columbia.

At Mount Pleasant the soft porous brown rock was a great drawback to successful farming and it was stacked in piles out of the way, used for foundations and for repairing the roads. In fact a farm with much rock on it was not considered worth more than five or ten dollars an acre. Now this same rocky land is selling for $1,000 an acre. It is said that shortly before phosphate rock was discovered a farm was taken for a debt of $1,400 and the man who took it felt that he had lost on the transaction. Now his holding is worth $60,000.

The United States is not the only country developing the phosphate rock industry. There are large deposits in Algeria, Tunis, South Sea Islands, and to a lesser extent in Canada and South Australia. Christmas Island, Ocean Island and Pleasant Island have been supplying high grade rock to Europe, Australia and Hawaii for some time. Christmas Island lies just south of Java, and has a population of about 700 natives. The phosphate rock from this island is extremely high grade, containing as much as 85% tri-calcium phosphate. The fields are in the northeast corner of the island and were exploited in 1900 by the Christmas Company, Ltd. In 1901 over 50,000 tons were shipped to Europe

and Australia. Later, the production reached 100,000 tons per annum. During the same year the Christmas Island rock was exploited, Mr. A. Ellis, of the Pacific Islands Co., discovered phosphates on Ocean Island. Banaba, or Ocean Island, as it is commonly called, is a coral island nearly circular, and about two and one-half miles in diameter. About half the area is occupied by villages and cocoanut groves, and the other half is phosphate fields. At the time of discovery the island was independent, but at the suggestion of the phosphate people it was taken over and proclaimed British soil in 1901.

In 1903 the Pacific Islands Co. became the Pacific Phosphate Co. of London, which is the company now supplying Hawaii with rock. The company has the privilege of working the island for a period of 99 years, paying the natives a royalty of sixpence (6d.) for every ton shipped. Should the natives wish to sell outright, they may at about $100 per acre.

Ocean Island phosphate is of very even quality, running about 80% tri-calcium phosphate, and it is estimated that the island contained from 35 to 40 million tons.

The method of working the fields is very simple, most of it being hand work. The surface soil, roots, etc., are removed and the phosphate below is scraped into piles from which it is dumped into small cars which take it down to the main bins. The phosphate varies in depth from 5 to 35 feet. Several acres are under galvanized iron roofing and yield a phosphate with about 6% moisture. Four dryers have been installed. They have a capacity of 100 tons each in 22 hours, removing all but 4 or 5% of the moisture from the rock.

The most difficult part of getting out phosphate is not the mining, but loading the rock on steamers. The island is coral, as mentioned before, and outside the reef the bottom sloped down at an angle of 45° with no holding ground. Three moorings have been laid 1,200 feet off the reef at a depth of about 280 fathoms. These are said to be the deepest moorings in the world. The steamers tie here while the phosphate is carried out in surf boats, each having four baskets carrying a half ton apiece. The loading is of necessity slow work and if the surf is running cannot be carried on at all. In bad weather the steamers have to wait outside for as long as a month at a time for a cargo.

Pleasant Island is owned by the same company, and is the island from which our phosphate now comes. It is about 150 miles northwest of Ocean Island, and is estimated to contain 50 to 60 million tons of rock equal in purity to that of Ocean Island.

It might be well to mention here Wyoming, Idaho and Utah phosphates, which have been discovered recently, and which may in the future supply Hawaii with part of our Superphosphate. These phosphate beds are brown in color and extend over a large area of the above named states. Some of it is even now mined

commercially and shipped to the San Francisco Chemical Co., where it is made into Superphosphate.

The material seems to be quite uniform in content, containing about 30-32% Phosphoric Acid. The prosperity of these fields depends upon the granting of railroad rates which will make it possible for this material to compete in the markets of Hawaii, Japan and Australia.

Phosphate rock passes through three stages before it becomes a commercial product:

1. Mining or excavating;
2. Washing free of impurities,
3. Drying to free it from moisture.

The mining is done with dredges, steam shovels and pumps, while of course much of it is still taken out with pick and shovel. In Florida some phosphate has been worked by hydraulic mining.

The phosphatic material containing sand, mud or other impurities is passed through a crusher where the large boulders are reduced to four inch lumps. From this machine it is carried in various ways to the washers where the sand and clay are washed out. The washing apparatus consists of a series of semi-circular troughs about 20 to 30 feet long and having a revolving shaft with blades which push the rock along. The machine has a pitch of about 1 in 6, and is set in water or has a stream of water entering the upper end. The rock is dumped at the lower end, and is gradually moved upward by the blades, against the current of water.

The most primitive way of drying is to pile it on racks of cord wood and fire the pile whereby the moisture is effectually driven out. Hot air and rotary kilns are also used for drying. The phosphate is now ready for sale, and this brings us to the subject of Superphosphates.

SUPERPHOSPHATES.

I suppose everyone is now more or less familiar with the Rothamstead experiments which have been conducted in England for the last fifty-five years, but few are familiar with the fact that the superphosphate industry, which now turns out over 86 millions dollars' worth of acid phosphate, originated with the late Sir Bennett Lawes, who was the founder of the Rothamstead experiments and on whose farms they have been conducted.

Mr. Lawes was impressed with the effects produced by ground bone, ground phosphate rock, and the same material dissociated by the use of sulphuric acid, upon some pot experiments he was carrying out. Especially noticeable was the effect produced on turnips by ground bone and coproliths dissolved by acid. Realizing the importance of his discovery, Mr. Lawes took out a patent for the manufacture of superphosphate in 1842, and thus founded

the industry which has since advanced so rapidly upon its merits.

The new fertilizer gave such wonderful results that soon after the first factory was erected in Deptford another was started at Barting on the Thames.

In 1862 a World's Fair was held in London, and on this occasion foreign jurors were invited to inspect the plant at Barting. Up to this time superphosphates were unknown in France, but on recommendation of the French jurors M. Ronna was sent to England to study the manufacture of superphosphates. His report appeared in 1864, and from this time dates the manufacture of superphosphates in France. France produces today about 1,300,000 tons, valued at nearly fifteen million dollars.

The manufacture of superphosphate, acid phosphate, one-lime phosphate, or water soluble phosphate, as it is variously called, is the changing of tribasic phosphate of lime (which we have been discussing and which is insoluble in water) into a salt which is more easily soluble. This is not a difficult matter theoretically since phosphoric acid is easily replaced by sulphuric. In fact we can add one, two, or three equivalents of sulphuric acid and a little water to calcium phosphate and get citrate soluble phosphate, water soluble phosphate, or phosphoric acid just as we please, all of which may be pure and of excellent mechanical condition on paper. The manufacture of a commercial product, which shall fill all the requirements both chemical and physical is a somewhat different matter.

In the first place fine grinding of the rock is universally conceded. There are numerous mills for this purpose which we need not take time to discuss. Suffice it to say that the material should pass a 60 mesh sieve and as much as possible be of a floury consistency. The finely pulverized rock is now analyzed and the amount of sulphuric acid sufficient to combine with the different bases is computed. This includes not only the calcium phosphate, but also phosphates of iron and aluminium, calcium and magnesium carbonates, and fluoride of lime.

The acid used is chamber acid of 50 to 56° Bé., corresponding to a specific gravity of 1.526 to 1.629, and depends upon the nature of the rock treated. The common practice is to use acid from 50 to 52° Bé. The reason for using chamber acid is that the resulting salts, gypsum and mono-calcium phosphate, are both hydrated products requiring a certain amount of water for their formation.

Mixing takes place in a wrought iron or lead lined pan provided with adequate stirring devices. About 500 lbs. of the finely ground phosphate rock is stirred in the pan, together with the requisite amount of sulphuric acid. The reaction commences at once and in a few minutes a complete mixture is obtained whereupon it is dropped into the pit below. The temperature rises rapidly to 110° C. or over and a large quantity of gases are liber-

ated, together with water vapor which are conducted to the chimney and escape. The reaction goes on to completion in the pit and the mass as it cools, gradually solidifies into a single, porous cake of superphosphate.

Any one, or all of three reactions may take place, viz:

I. $Ca_3P_2O_8 + H_2SO_4 + 6H_2O = Ca_2H_2P_2O_8.4H_2O + CaSO_4.2H_2O$

II. $Ca_3P_2O_8 + 2H_2SO_4 + 5H_2O = CaH_4P_2O_8H_2O + 2(CaSO_4.2H_2O)$

III. $Ca_3P_2O_8 + 3H_2SO_4 + 6H_2O = 2H_3PO_4 + 3(CaSO_4.2H_2O)$

Reactions II and III are the desirable ones and No. II is the one aimed at here in Hawaii where a water soluble material is most desired. Even with the most careful calculations it is often found that a slight change in the proportion of acid to phosphate would be of advantage, but this is a matter of experience and can only be determined after a batch of "super" has been made and analyzed. If too little acid has been used the mass is very dry and there is a large amount of rock left unacted upon. If too much has been used a very muddy, sticky, mass results which is very hard to handle and which drys with difficulty.

After standing in the pit for 24 hours it may be dug out with pick and shovel and conveyed to the bins where it ages for a month or more. It is here that the damage is done should the "super" have been improperly made or if the rock contained a high per cent. of iron and alumina. A series of secondary reactions set in whereby the mono-calcium phosphate and free phosphoric acid are changed into di-calcium phosphate. If the decomposition of the rock has been incomplete the result is the same.

$2Ca_3P_2O_8 + 2H_3PO_4 + 12H_2O = 3Ca_2H_2P_2O_8.4H_2O$

$CaH_4P_2O_8 + Ca_3P_2O_8 = 2Ca_2H_8P_2O_8$

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*SOURCE AND MANUFACTURE OF FERTILIZER INGREDIENTS.

R. A. Lyon.

The above topic being so broad, this paper is of necessity but a swift running over of the general subject with brief stops at points of principal interest, in order that it may not stretch over the half hour period. Some portions of the paper, culled from standard fertilizer authorities, owing to their triteness of expres-

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* Read at a meeting of the Hawaiian Chemists' Association, Sept. 5, 1908.

sion, have been included verbatim. The subject of superphosphates is not treated here, as a separate paper on that topic is being presented at this meeting of the Association.

The factory manufacturing, or mixing and grinding complete fertilizers draws its ingredients from widely scattered points on the earth. So that it is not only the cost of mining and refining the raw products, and the mixing, grinding, screening and sacking them that fixes their final price to the consumer. Freight, insurance and duty are also heavy factors.

The chief source of nitrogen is the immense rainless desert plains of Chili, from which nitrate of soda is supplied to the world. The export of this valuable salt, which was but 8,350 tons in 1830, last year had risen to 1,600,000 tons. The price (and tonnage output of each refinery) is fixed every twelve months by the Nitrate Syndicate, which controls all the nitrate works. It has risen from $28 to $52 in ten years. To show how quickly the market varies it is today from $8 to $10 cheaper than one year ago.

The crude salt, or caliche, as it is called, contains from 20% to 55% sodium nitrate. It is found in beds from 5 to 7 feet deep lying near the surface, and covered with a layer of rock debris, cemented together by salt and gypsum. As this is a rainless district, and water, fuel, etc., have to be brought in, the cost of refining is materially increased. The raw material is blasted out, hauled in cars to the works, where it is crushed and boiled with water, which is run off into crystallizing tanks in the open. After crystallizing, drying and sacking, the nitrate of soda, analyzing about 15% nitrogen, is ready for market. The mother liquor retains most of the chloride, and iodide and iodate of sodium and magnesium and about 20% of nitrate soda. It it diluted with the wash waters of the residue and used to lixivate a fresh supply of crushed caliche. After severad repetitions of this process, the mother liquor, now heavily contaminated, is run off to the iodine works. The blasting powder necessary in getting out the caliche is also manufactured as a by-product.

Ammonium sulphate is a by-product in the conduction of enterprises undertaken primarily for the production of some other substance, the output being controlled, not by the demand for ammonium sulphates, but by the demand for the chief product. These enterprises are principally gas works, coke ovens and shale plants.

Great Britain produces about 50% of the world's supply, the United States only about 14%. Of the 280,000,000 tons of bituminous coal produced in the United States in 1904, only about 7,000,000 tons were treated in by-product coke ovens or coal gas retorts, by which method the nitrogen recoverable as ammonia can be saved. Even if the 40,000,000 tons of coal annually made into coke were treated by by-product methods, we would thus be

producing 60% of the world's supply or 400,000 tons of ammonium sulphate.

The manufacture involves, first, the destructive distillation of the coal under heat in a closed retort or oven. This sets free a portion of the nitrogen as ammonia, which passes away with the gas and is absorbed from it by water, as the gas is being cooled and scrubbed. The liquor containing the ammonia gas in solution is then heated with steam in a still and the ammonia comes off as a gas mixed with water vapor. This is led into a bath of sulphuric acid where it combines as ammonium sulphate, which is crystallized out, dried, sacked and sold as commercial ammonium sulphate, containing about 25% ammonia.

The market for some years has varied from £11 to £12 per long ton in Europe. Freight has varied from $3.50 to $7.50 per ton and the custom's duty is three-tenths of a cent per pound. The amount used annually in this Territory costs about $500,000 and pays a duty of close to $50,000. This seems an ideal starting point in the revision of the tariff as this duty is an unjust hardship on the American farmer.

The meat packing industry of the United States, among other by-products, produces nitrogenous substances such as blood, tankage, bone and hoof meal, etc. This source supplies more nitrogen in the United States for fertilizer purposes than all the other sources combined. Tankage and blood have increased materially in price in the last few years, owing to the increasing demand and the fact that the big packing houses control the market and arrange prices accordingly. It is all sold on the unit basis, tankage from $2.30 to $2.80 per unit of ammonia and ten cents per unit of bone phosphate of lime, while blood runs from $2.50 to $3 per unit of ammonia. These quotations refer to prices f. o. b. Chicago or Kansas City. Honolulu blood and tankage has to stand a freight of about $14 per ton from the middle west shipping point. Tankages run all the way from 7% to 13% total phosphoric acid, 3% to 7% available phosphoric acid, and from 6% to 10% ammonia, the availability of the phosphoric acid content depending chiefly upon the fineness of the material. Blood, which is put upon the market in the shape of a dry reddish-black powder, much resembling gunpowder, runs from 12% to 17% ammonia.

Whole guano is a form of organic nitrogen produced on Vancouver Island by the Pacific Whale Company, as a by-product. Its nitrogen content is equivalent to from 12% to 14% ammonia. Part of the output comes to Honolulu and the major portion of the balance goes to Japan.

Fish guano usually runs from 10% to 19% ammonia and from no phosphoric acid to 10%. That produced upon the Pacific coast is manufactured chiefly from the refuse of salmon canneries and as a by-product of the fisheries in Alaska. About 1,000 tons are manufactured annually, most of it coming from Killisnoo,

Alaska, where it is made from herring caught for the purpose of extracting the oil. The fish are steamed and the oil pressed out, the residue being dried, ground and sold as fish guano. The industry is an immense one on the Atlantic coast, the American Fisheries Company having many steamers catching menhaden, which run in large schools from the Bay of Fundy south to Florida. Their oil and fish guano factories produce annually from 60,000 to 80,000 tons of guano.

Other nitrogenous guanos are formed by the deposits of bird life in various arid regions, some of it being exceedingly rich. Some Peruvian guano contains about 8% potash, from 32% to 36% sulphate of magnesia, and is rich in ammonia.

Soluble bat guano has been found in the caves of Indiana, Alabama, Kentucky, Cuba, Jamaica and Mexico. It is exceedingly variable in analysis, running from 8% up to 30% ammonia, some samples containing uric acid.

The manufacture of the synthetic nitrogen compound, calcium cyanamid or lime nitrogen, is reaching large proportions in Europe, though still in its infancy in America. The manufacturing processes are roughly the following. Coke and high grade lime are crushed, mixed and subjected to an electric heat of about 6,000 degrees F. when calcium carbide is formed. This is finely pulverized and heated to redness. Nitrogen, most cheaply derived from liquified air by distillation, is then passed through it, forming calcium cyanamid.

This material ranks in value for agricultural purposes with ammonium sulphate and in its final action equals nitrate of soda. Its high content of lime, activity in periods of drought, non-volatile character, and the drying or anti-caking effect it has on a fertilizer mixture greatly enhance its value to the consumer. On the other hand, from the manufacturer's standpoint, it is hard to handle, being very powdery and dusty. It takes up moisture very rapidly and increases in bulk, so that it cannot be shipped any great distance in bags. It is at present shipped to Honolulu in iron drums. These are, of course, hard to handle in the factory. The present price is from $60 to $65 per ton. In a sample of lime nitrogen analyzing 18.95% total nitrogen, 15.45% was nitrogen water soluble as cyanamid, and 1.35 nitrogen water soluble as ammonia. 1.06% nitrogen proved to be unavailable and 17.89% nitrogen or 94.4% was available as plant food.

Muriate of potash and kainit furnish potash as chloride. They are both white, readily water soluble salts mined at Stassfurt, Germany. They analyze about 50% and 13% potash respectively. Some high grade muriate, running about 60% potash, is also made in Japan as a by-product in the iodine industry.

Sulphate of potash and the double sulphate of potash and magnesia (commonly called double manure salts), furnish potash as sulphate, about 49% and 26% potash respectively. They are

fine whitish crystalline salts, water soluble and readily available, also mined at Stassfurt.

The price of potash salts has varied but slightly in several years, so far as the German market is concerned. But the cost in Honolulu has varied, as freight rates have varied, from $3.50 to $7.50.

Scientists generally agree that the potash minerals of Germany were deposited from sea water in some remote period in much the following manner: Most of the territory of the present empire was an immense shallow lake or bay, cut off from the sea at ordinary tide by sand bars and shallows, so that the waters within were concentrated by evaporation. This basin was surrounded on all sides but the north by mountain ranges, and as the surface of the waters in the basin fell by evaporation, limited amounts of sea water entered through the sand banks. The solid constituents gradually concentrated until a point was reached where the less soluble salts were crystallized out and precipitated. The same action is going on today in a similar arm of the Caspian Sea in which 100,000 tons of rock salt are daily deposited in this single inland gulf. The least soluble and first precipitated salt was calcium sulphate. As the water increased in concentration the salt next in solubility, namely sodium chloride was precipitated. As this salt is the highest percentage of the solids in sea water, large quantities were deposited each year. It probably took thousands of years of sodium chloride depositing before the huge basin was filled solid with this salt, in some places to the depth of 1,200 meters. In the whole course of the process the magnesia salts and chloride of potash, owing to their high solubility remained floating above the sodium chloride deposits, and would have flowed into the sea when the water reached sea level had it not been for some volcanic or other upheaving action which raised the deposits and the accumulation of sand bars. This stopped the entry of sea water and allowed this inland sea of mother lye to crystallize out in a relatively pure layer over the other salts. After a saliferous clay deposit had time to cover these potash deposits it is probable that the sand bars were again partially broken, sea water rushed in, again started evaporating, and deposited a new protecting layer of rock salt. It is evident that nature did not again shut out the sea water inflow, as these upper rock salt deposits are, like nearly all other rock salt beds of the world, free from deposits of potash.

In 1851 the first salt shaft was sunk by the Prussian government at Stassfurt, which was the beginning of the immense industry that supplies the world today with mineral potash. It was many years before the value of potash salts, which had at first been despised by the salt workers, became recognized, and then shafts were drilled all over Germany. In 1883 a consolidation of the principal mines was consummated which resulted in the

great German Potash Syndicate, organized at Stassfurt in 1886. This syndicate controlled absolutely for a quarter of a century the German potash industry. The fact that about 54% of the output was used in the United States, led American capital to try to break into the business, and in 1902 a few mines were acquired. This alarmed the syndicate and forced it to take in eighteen outside firms, so that in 1904 it had a producing power far beyond the market requirements at syndicate prices. A conference was held in Berlin in 1905 for the purpose of allotting the amount each mine should be allowed to produce annually for a period of five years. It is understood that the American Fertilizer Syndicate holds a satisfactory contract for the delivery of a large annual supply of potash salts, the discounts being graded in proportion to the amount purchased. The American representatives who negotiated this treaty have expressed the opinion that the interests of the consumers in the United States could be better served in this way than by any effort of outsiders to buy and work potash mines in Germany in opposition to the syndicate. This may or may not be true, but the control of the potash supply is one upon which German public feeling is sensitive, and all efforts of foreigners to gain a foothold in this industry have been regarded as an unwarranted intrusion. The value of potash as a fertilizer is now fully realized by German agriculturists, a million tons having been used by them in 1903. This was treble the amount used ten years previous.

It is an interesting fact that while the United States is practically dependent upon Germany for potash fertilizers, and is the largest foreign consumer of such products, Germany is equally dependent upon the United States for mineral phosphates, 76% of the natural phosphates imported into Germany in 1902, for instance, coming from the deposits of the Southern Atlantic States alone.

The source of potash as carbonate is principally wood ashes, the composition depending upon the character of wood used and the care taken in preservation. Unleached hard wood ashes contain from 4% to 8% potash and 1% to 3% phosphoric acid, while leached ashes contain from 1% potash and upwards.

Some potash as vegetable organic matter, such as finely ground tobacco stems, etc., is also upon the market, but although when properly manufactured it is quite effective, it is less readily available than other forms.

Phosphoric acid from bones comes in many forms, namely, bone flour, bone meal, steamed bone meal, dissolved bone, bone black, and dissolved bone black.

Bone meal in crushed or ground bone and the availability of its phosphoric acid depends largely upon the fineness of material. Good bone meal contains from 3% to 5% nitrogen and from 18% to 20% phosphoric acid.

Steamed bone meal contains only about 2% nitrogen but from

22% to 29% phosphoric acid. The loss of nitrogen by steaming is partially made up by the increased availability of this fertilizer.

Dissolved bone meal is made by treating the raw meal with sulphuric acid. It contains from 2% to 3% nitrogen and from 15% to 17% available phosphoric acid.

Bone black is manufactured by dry distillation out of air contact. It contains little or no nitrogen and about 30% total phosphoric acid. It is extensively used in sugar refineries. After it becomes useless for this purpose it is sold as a fertilizer. As its phosphoric acid is chiefly insoluble phosphate of lime mixed with carbon it does not decompose readily in the soil, and is chiefly used for the manufacture of dissolved bone black by treatment with sulphuric acid. This renders from 15% to 25% of the phosphoric acid available.

Phosphoric acid also comes in the forms of phosphatic guanos, tankages, basic slag, super phosphates, and the double super phosphates from Belgium.

Basic slag is a by-product from the manufacture of steel by the modified Bessemer process. The pig iron, which contains from 2% to 4% of phosphorus is melted and run into a Bessemer converter, lined with dolomite powder cemented with coal tar, into which has previously been placed a certain quantity of freshly burned lime. For an average content of 3% phosphorus in the pig iron, from 15 to 20 pounds of lime are used to each 100 pounds of iron. As soon as the melted iron is introduced into the converter ,the air blast is started, the converter placed in an upright position, and the purification of the mass begins. The manganese in the iron is converted into oxid, the silicon into silica, the carbon into carbon dioxid and oxid and the phosphorus into phosphoric acid. By reason of the oxidation processes, the whole mass suffers a rise in temperature of about 700 degrees above the temperature of the melted iron. At this temperature the lime melts, combines with the phosphoric acid and the liquid mass floats upon the top of the metallic portion which has by this process been converted into steel.

As soon as the process, which occupies about fifteen minutes, is completed, the fused slag is decanted off into moulds, allowed to cool, broken up and ground into a fine powder. This basic slag contains 17 to 30% phosphoric acid in the form of tetracalcium phosphate. The grade of slag produced depends, of course, upon the content of phosphorus in the pig iron used. The availability of its phosphoric acid content upon the percentage of fine material it contains.

The phosphoric acid in slag is in a form which cannot revert or go back to insoluble forms in the soil. The high content of lime, though prohibiting its use in a mixture containing ammonium sulphate, makes this material especially valuable for the reclamation of sour soils. It possesses the valuable property of making available the potash already in the soil and the crude

forms of organic nitrogen therein. It also possesses the physical property of loosening up compact clay soils and compacting light porous soils, making them more retentive of water and plant food. The 3% to 6% magnesia content of basic slag has also a beneficial action upon the crude forms of plant food in the soil, rendering them more available.

SOME STATISTICS ABOUT THE JAVA SUGAR PRODUCTION.

The history of the cane sugar production in Java during the last decade has been one of uninterrupted progress, which is the more noteworthy as this constant and regular increase in the yearly export is not a consequence of an artificially stimulated growth, but of a sound development of our resources.

The extension of the planted area is shown in this table:

Year.	Per Ct.	Coums.	Hectares.	Acres.	No. of Estates.
1898	100	113,207	80,337	198,500	188
1899	104	117,632	83,477	206,440	183
1900	113	127,916	90,775	224,100	183
1901	127	143,349	101,694	242,100	182
1902	129	145,463	102,835	256,000	183
1903	128	145,454	102,810	249,000	178
1904	130	146,402	103,894	259,000	176
1905	131	148,514	105,393	260,490	173
1906	137	155,659	110,463	272,970	176
1907	143	162,452	115,338	285,017	176
1908	144	162,627	115,458	285,289	177

The rapid extension of the land under cane in the years 1899-1901 was a consequence of an ordinance issued by the government, fixing the area of every estate at the existing surface *in maximo*, with a view to reserving sufficient land for the rice cultivation of the natives. This maximum may not be exceeded without special permission of the governor-general, who examines in every case if a further extension of the land allotted to some estate can be granted without prejudice to the wants of the native population as respects land and irrigation water. As however a term of three years was allotted before the ordinance came into force, the mill owners made use of that delay to plant as much land as they could and thus increase their legal maximum. It was some time before the factory plans were adapted to the now so suddenly increased supply of cane and therefore the maximum area, reached in 1901, remained pretty well unchanged as far as 1905. The gradual improvement in the factories' outfit and the combination

of some smaller estate into central factories soon required fresh extension of land, so that already in 1906 new concessions were granted to already existing factories, which caused an increase of 14 per cent. of the 1898 area in one year. At the same time new estates were opened, some in places where new irrigation canals had rendered sugar cultivation practicable and others on land which formerly had belonged to indigo estates. Since the competition of the German synthetic indigo has restricted the demand of the natural dye-stuff, several indigo plantations lost confidence in its cultivation and preferred to plant cane and either sell this to sugar planters or combine and build a sugar factory themselves. The number of estates which, owing to the concentration of small estates into large concerns, had diminished from 188 to 173, increased by the reasons mentioned above to 177 in 1905, which number is sure to go on rising because some new factories are still planned in several parts of the island. Moreover the existing estates are all endeavoring to enlarge their concessions. So that I believe that the coming years will show a gradual rising of the figures for the acres under cultivation.

From this area the following quantities of sugar were obtained, which all are treated on the surface without allowance for low or salt parts or rocks:

Year.	Cane per acre Long tons-cwt.	Sugar per acre Long tons-cwt.	Per cent.	Sugar production Metric tons.
1898	34.12	3.11	10.21	725,030
1899	32.9	3.11	10.94	762,447
1900	33.10	3.4	9.57	744,257
1901	30.5	3.2	10.16	803,735
1902	31.11	3.8	10.77	897,130
1903	35.11	3.11	10.04	952,307
1904	37.15	4.1	10.74	1,055,043
1905	37.16	3.18	10.37	1,039,178
1906	38.6	3.16	10.04	1,067,798
1907	38.15	4.3	12.03	1,210,197

My tabulation of the results of the 1908 crop gives a total figure which is only very little under the record figure for 1907. The weight of the cane per acre is less, but this is almost completely made up by a very high sucrose content of this year's canes.

We see that the production is steadily increasing, the tonnage of cane per acre rose from 34.12 to 38.15 tons, or 110 per cent., and that of sugar per acre from three tons, eleven hundredweight to four tons, three hundredweight, or 117 per cent., whilst the whole production increased from 725,030 tons to 1,210,197 tons, or 167 per cent. in ten years. The steadily larger production is therefore only partly due to the planting of more land and also

for a great deal to a larger production of cane from the same surface, and also, but to a smaller extent, to the improved yield of sugar from a same quantity of cane. Notwithstanding the greater attention paid to the manufacture of the sugar and to the better extraction of juice from the cane the percentage of 100 parts of cane has not risen considerably, which shows that the real sucrose content of the cane must have suffered by the methods which stimulated its growth and its weight. But anyhow, the total yield throughout the whole island is improved, as is shown in this table, where for every year under consideration the maximum yield of a whole estate's area per acre is recorded and at the same time the number of estates making over five long tons of sugar per acre:

Year.	Maximum yield per acre in long tons.	Number of estates making more than 5 long tons per acre.
1898	5.1	1
1899	5.7	2
1900	5.2	1
1901	5.0	0
1902	5.3	1
1903	5.8	7
1904	5.18	9
1905	5.10	7
1906	4.19	0
1907	5.15	10

H. C. PRINSEN-GEERLIGS, in Louisiana Planter.

Sugar Plantations, Cane Growers and Sugar Mills.

ISLAND AND NAME.		MANAGER.	POSTOFFICE.
OAHU.			
Apokaa Sugar Co	*	G. F. Renton	Ewa
Ewa Plantation Co	*	G. F. Renton	Ewa
Waianae Co	***	Fred Meyer	Waianae
Waialua Agricultural Co	*	W. W. Goodale	Waialua
Kahuku Plantation Co	x*	Andrew Adams	Kahuku
Waimanalo Sugar Co	**	G. Chalmers	Waimanalo
Oahu Sugar Co	x	E. K. Bull	Waipahu
Honolulu Plantation Co	**	Geo. Ross	Aiea
Laie Plantation	x*	S. E. Wooley	Laie
MAUI.			
Olowalu Co	**	Geo. Gibb	Lahaina
Pioneer Mill Co	x	L. Barkhausen	Lahaina
Wailuku Sugar Co	**x	C. B. Wells	Wailuku
Hawaiian Commercial & Sugar Co	x*	F. F. Baldwin	Puunene
Maui Agricultural Co	...	H. A. Baldwin	Paia
Kipahulu Sugar Co	x	A. Gross	Kipahulu
Kihei Plantation Co	x*	A. J. McLeod	Kihei
Kaeleku Plantation Co	...	John Chalmers	Kaeleku
HAWAII.			
Paauhau Sugar Plantation Co	**	James Gibb	Hamakua
Hamakua Mill Co	*x	A. Lidgate	Paauilo
Kukaiau Plantation	x	A. Horner	Kukaiau
Kukaiau Mill Co	*x	E. Madden	Paauilo
Ookala Sugar Co	**x	W. G. Walker	Ookala
Laupahoehoe Sugar Co	*x	C. McLennan	Papaaloa
Hakalau Plantation	**	J. M. Ross	Hakalau
Honomu Sugar Co	**x	Wm. Pullar	Honomu
Pepeekeo Sugar Co	**x	Jas. Webster	Pepeekeo
Onomea Sugar Co	**x	J. T. Moir	Hilo
Hilo Sugar Co	**	J. A. Scott	Hilo
Hawaii Mill Co	x	W. H. Campbell	Hilo
Waiakea Mill Co	*x	C. C. Kennedy	Hilo
Hawaiian Agricultural Co	**x	Wm. G. Ogg	Pahala
Hutchinson Sugar Plantation Co	**	Carl Wolters	Naalehu
Union Mill Co	*x	H. H. Renton	Kohala
Kohala Sugar Co	*	Geo. C. Watt	Kohala
Pacific Sugar Mill	x**	A. Ahrens	Kukuihaele
Honokaa Sugar Co	x**	K. S. Gjerdrum	Honokaa
Olaa Sugar Co	xx	J. Watt	Olaa
Puna Sugar Co	xx		Kapoho
Halawa Plantation	x*x	J. Atkins Wight	Kohala
Hawi Mill & Plantation	††	John Hind	Kohala
Puako Plantation	††	Jno. C. Searle	S. Kohala
NiuliiSugar Mill and Plantation	*x	Robt. Hall	Kohala
Puakea Plantation	...	H. R. Bryant	Kohala
Kona Sugar Co	...		Kona
KAUAI.			
Kilauea Sugar Plantation Co	**	F. Scott	Kilauea
Gay & Robinson	x*x	Gay & Robinson	Makaweli
Makee Sugar Co	...	G. H. Fairchild	Kealia
Grove Farm Plantation	x	Ed. Broadbent	Lihue
Lihue Plantation Co	x	F. Weber	Lihue
Koloa Sugar Co	x	L. Weinzheimer	Koloa
McBryde Sugar Co	*x	W. Stodart	Eleele
Hawaiian Sugar Co	x*	B. D. Baldwin	Makaweli
Waimea Sugar Mill Co	*	J. Fassoth	Waimea
Kekaha Sugar Co	x	H. P. Faye	Kekaha

KEY.

*	Castle & Cooke (0)
**	W. G. Irwin & Co (8)
***	J. M. Dowsett (1)
x	H. Hackfeld & Co (9)
*x	T. H. Davies & Co (8)
**x	C. Brewer & Co (6)
x*	Alexander & Baldwin (6)
x**	F. A. Schaefer & Co (2)
x*x	H. Waterhouse Trust Co (2)
††	Hind, Rolph & Co (2)
xx	Bishop & Co (1)

HONOLULU AGENTS